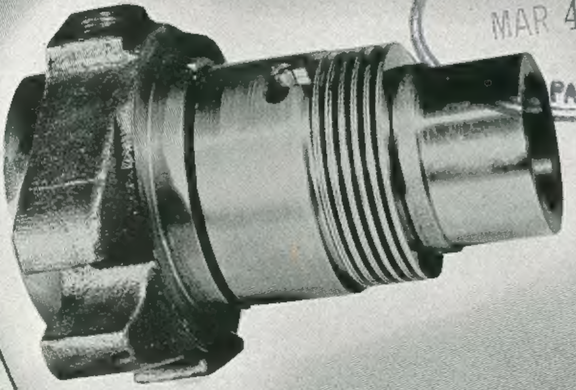
A slidefilm in booklet form

Ingersoll-Rand
Cameron Pump Division

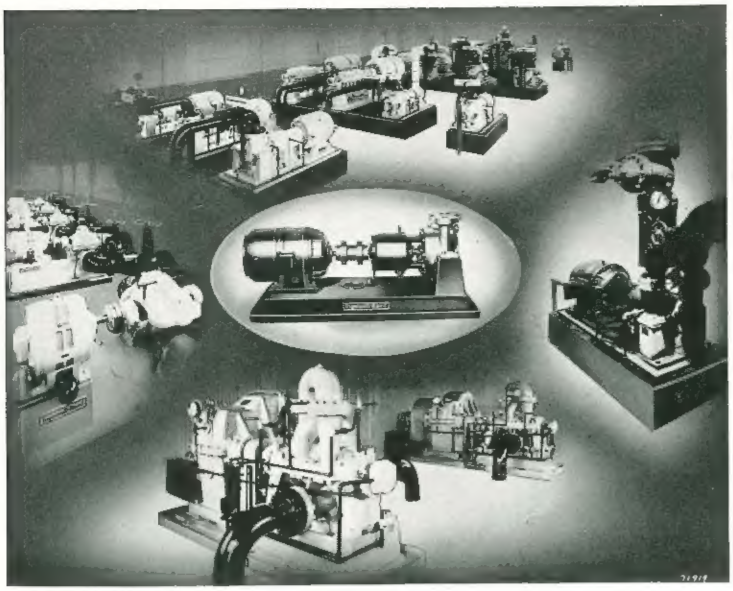
presents

The Story of the CAMERON SHAFT-SEAL

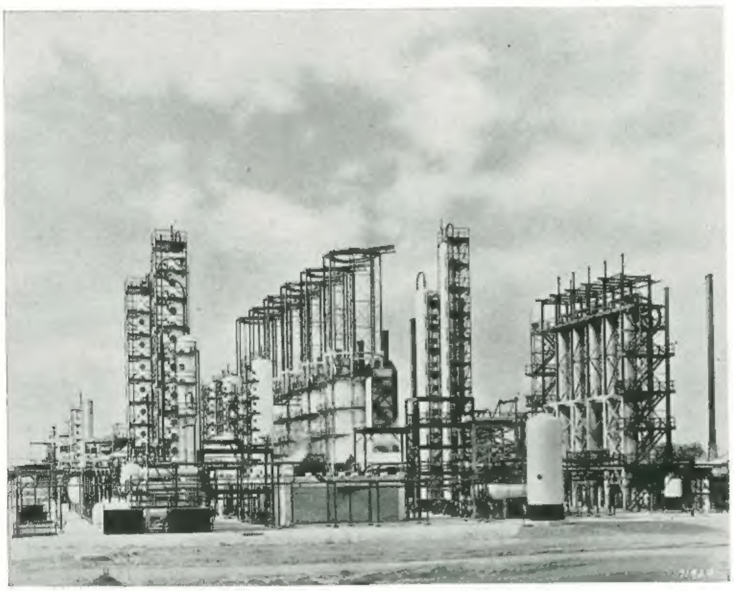


FOR USE ON
INGERSOLL-RAND PUMPS

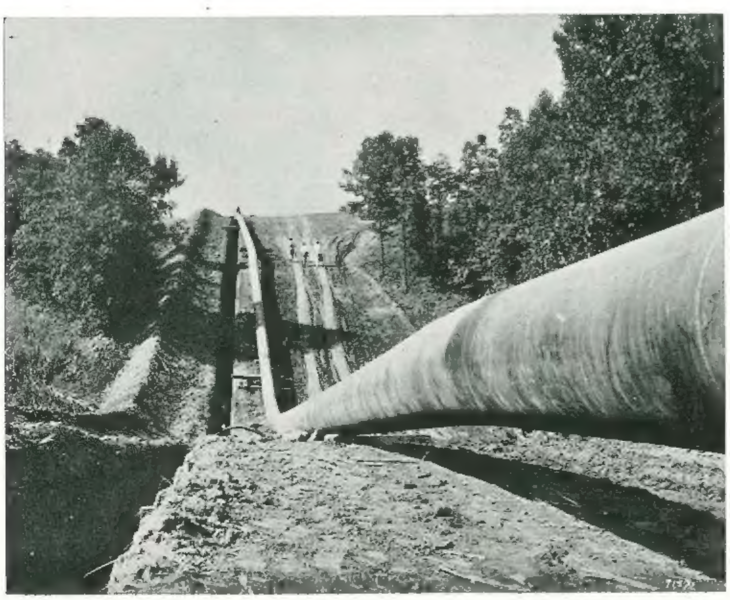
Bulletin 7124



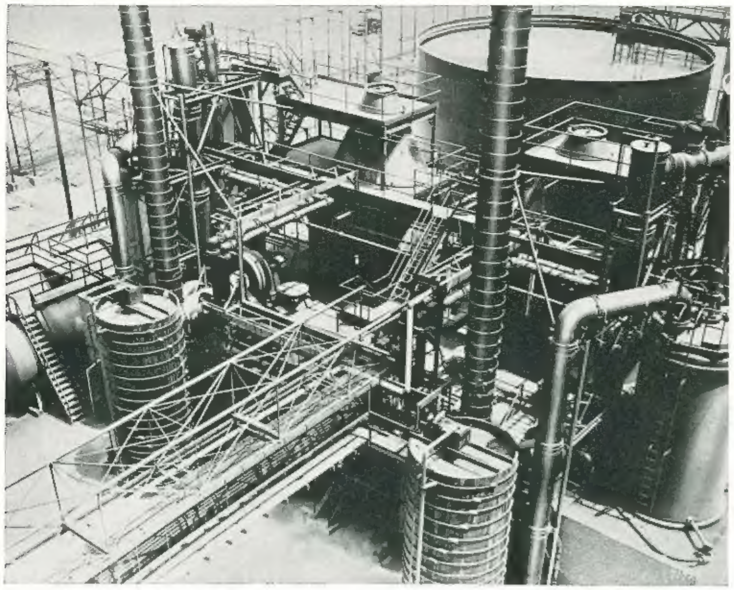
In the half-century since the advent of the centrifugal pump, these machines have created enormous savings in pumping hot and cold liquids, and more recently, corrosive fluids, and viscous or volatile hydrocarbons.



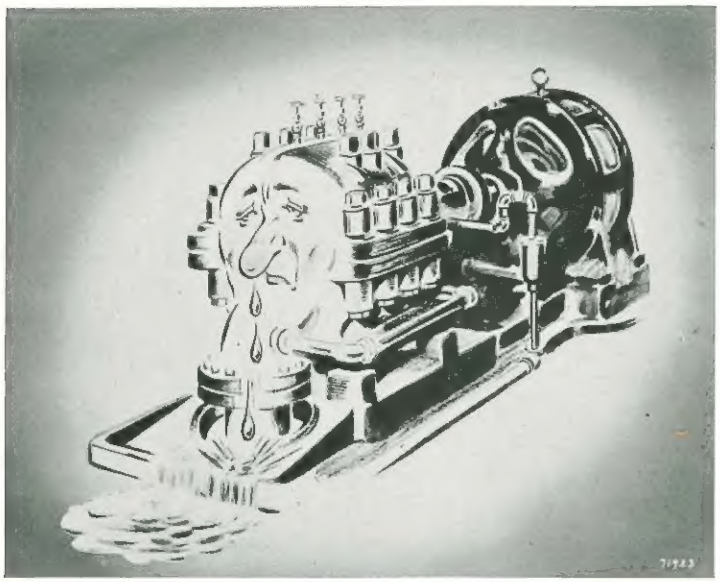
In refineries they play an important role in the constant movement of crude oil and petroleum products through the plant.



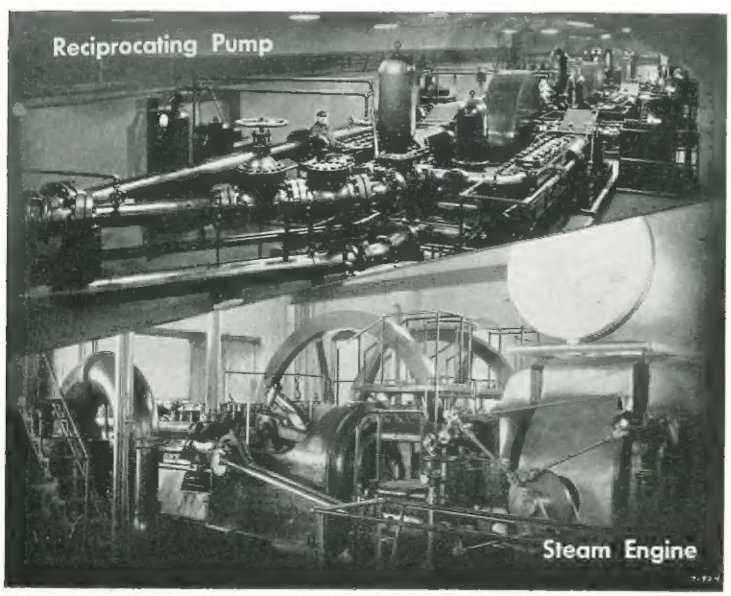
In pipeline service they are an invaluable aid in transporting crude oils to refineries . . . and finished products to distribution centers.



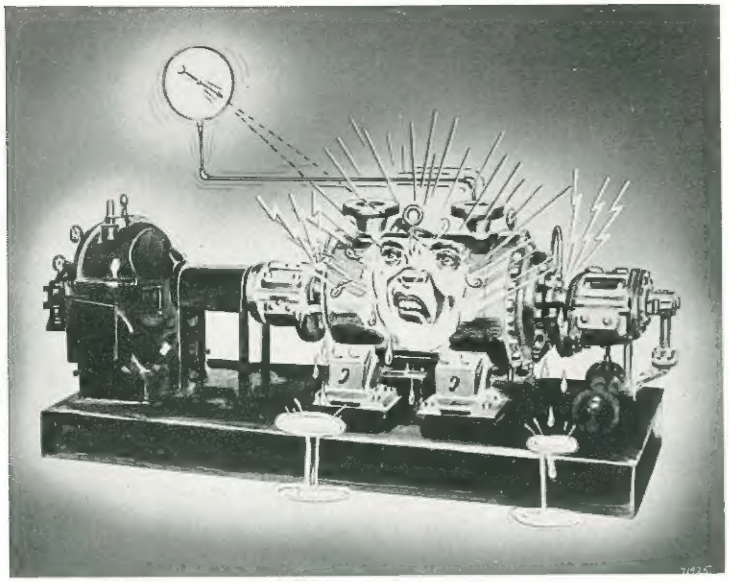
In the chemical industry they handle raw stock liquids, semi-processed fluids and finished products which include a wide variety of chemical solutions and acids.



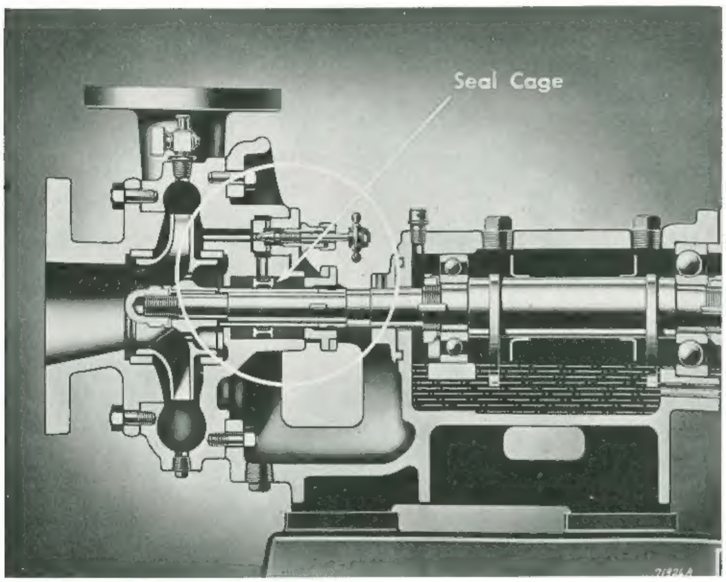
But ever since the first centrifugal pumps were built, the biggest problem has been to prevent the liquid from leaking out along the drive shaft.



Because early-day reciprocating pumps, steam engines, and similar equipment used the packing method to seal the shaft, it was first thought natural to apply this same method to centrifugal pumps.



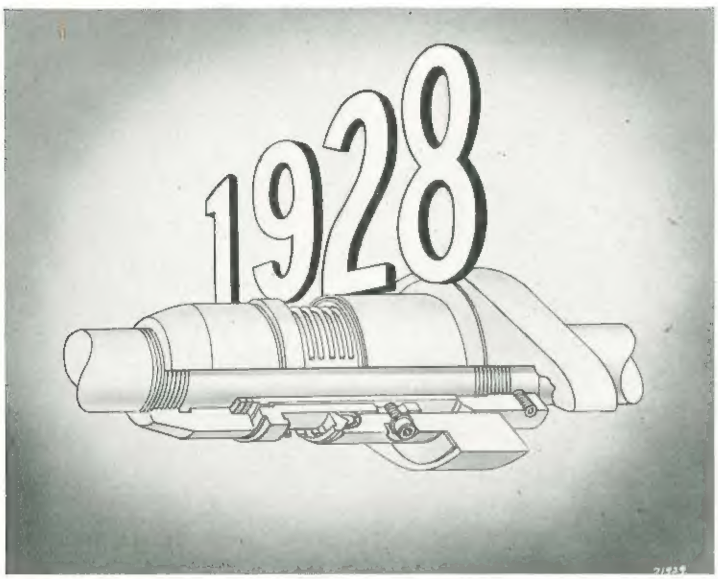
Soft packing was entirely satisfactory where speed and friction were moderate. But as the demands came for higher and higher pressure—speed and friction increased tremendously . . . creating new packing troubles.



One of the earliest developments toward solving the problem was a seal cage which used liquid from the pump casing to lubricate the packing.

There also were experiments with different kinds of packing—some semi-metallic in character. These increased the friction between the shaft and the packing, necessitating water-cooled boxes and shaft sleeves of harder, and more expensive, material.

As the difficulties grew, it became increasingly evident that an entirely new approach was necessary to the problem of sealing the shaft of the centrifugal pump.

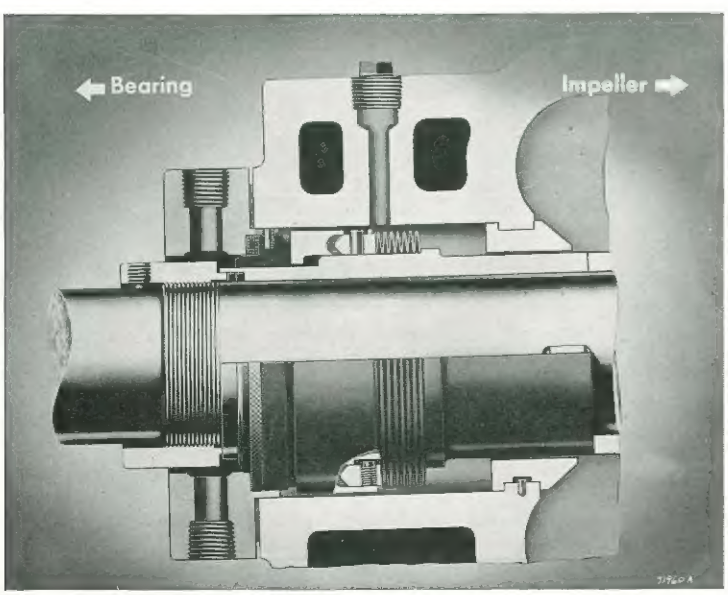


Ingersoll-Rand engineers were probably the very first to recognize this and in 1928 they turned out what was then a revolutionary mechanical shaft seal.

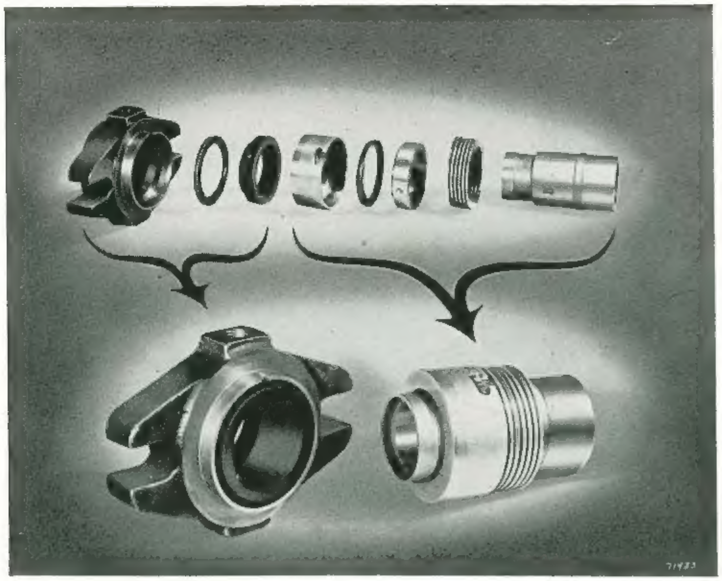
This seal was installed on pumps for the Atlantic pipeline and Texas pipeline . . . and demonstrated a vast improvement over the old-style packing methods. An improvement established by the fact that, to this day, they are still in use.

Still not satisfied, extensive experiments were conducted and changes in design were made by our engineers to eliminate maintenance difficulties in the original model . . .

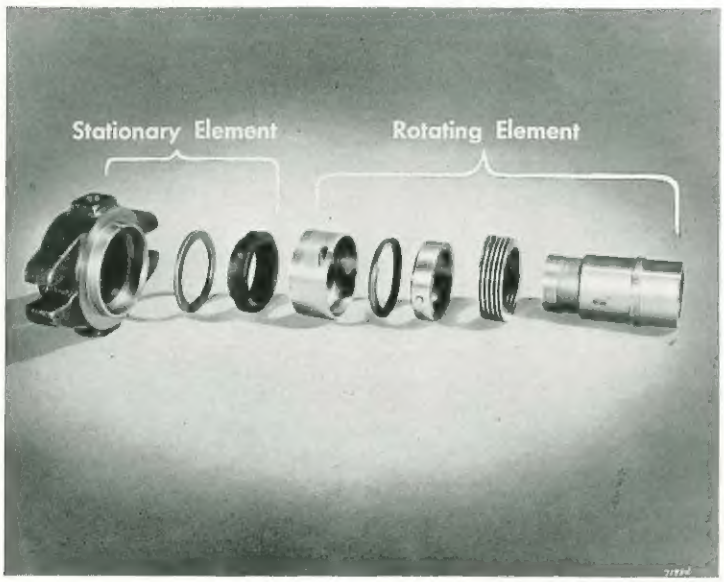
. . . finally resulting in the Cameron Shaft-Seal—the most efficient device for sealing centrifugal pump shafts ever developed. Now, let's really get into this thing and see what makes it tick!



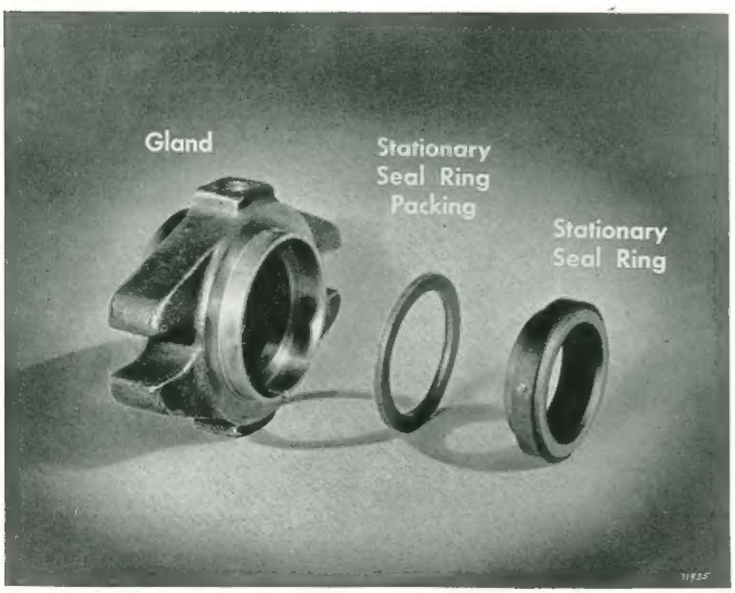
This cross section shows the Shaft-Seal installed in a standard stuffing-box. The arrows indicate the seal's position in relation to the bearing and the impeller.



The Shaft-Seal breaks down into eight component parts which make up the two main elements of the sealing device.



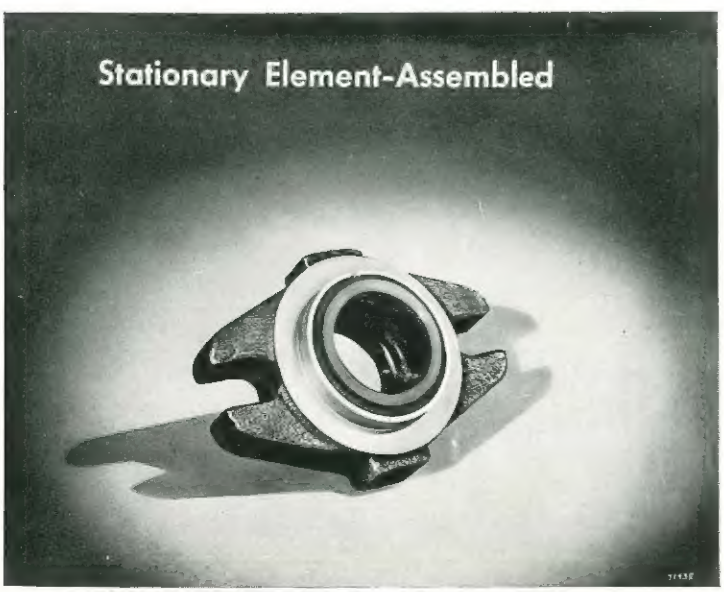
Three of the parts form the stationary element and the other five parts make up the rotating element of the seal. First, let's look at the stationary parts.



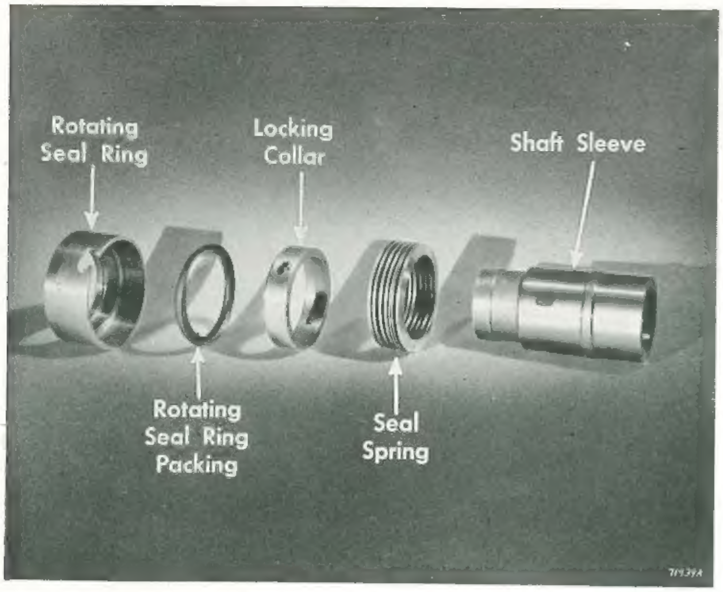
The stationary element is composed of a gland, a stationary seal ring packing and a stationary seal ring. The gland, which is either cast iron or steel, serves to hold the stationary seal ring in place, provides a seat for the packing ring between the seal ring and the gland . . . and closes off the stuffing-box.

The packing ring prevents escape of fluid around the stationary seal ring and provides enough movement to allow perfect contact between the sealing faces. This packing and the parts in contact with it, are stationary . . . which eliminates the possibility of wear.

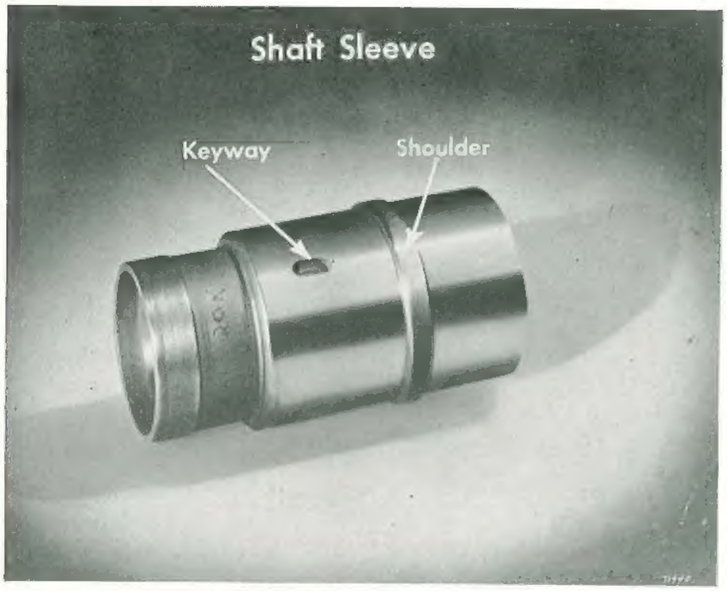
The third and most important part is the carbon stationary seal ring, shown here in two different views. The seal face is perfectly true and flat and, when brought into sliding contact with the rotating face under sufficient pressure, prevents the escape of fluid.



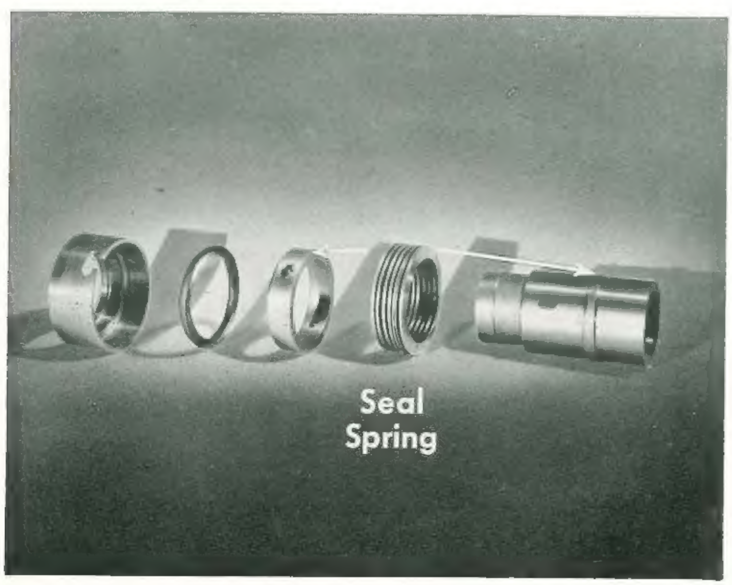
And that's the story, in a nutshell, as regards the stationary part of the Shaft-Seal. Now, let's look at the rotating element . . .



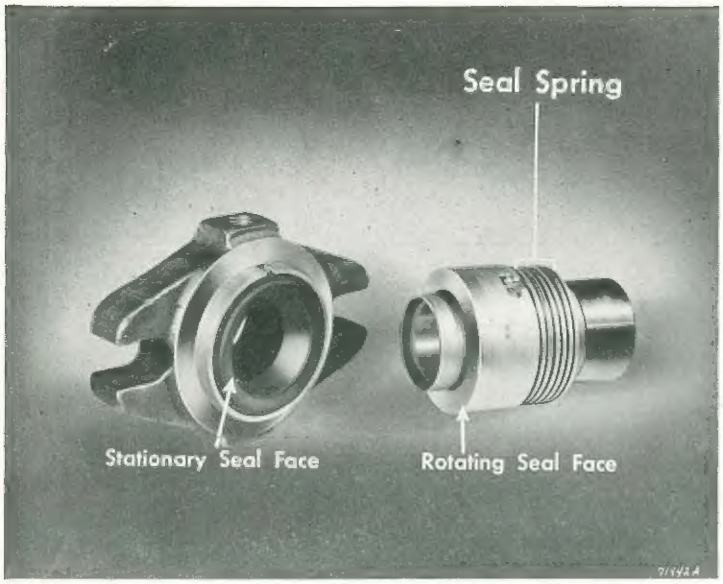
. . . which is made up of five parts—the rotating seal ring, the rotating seal ring packing, the locking collar, the seal spring, and the shaft sleeve. All parts are stainless steel with the exception of the packing ring.



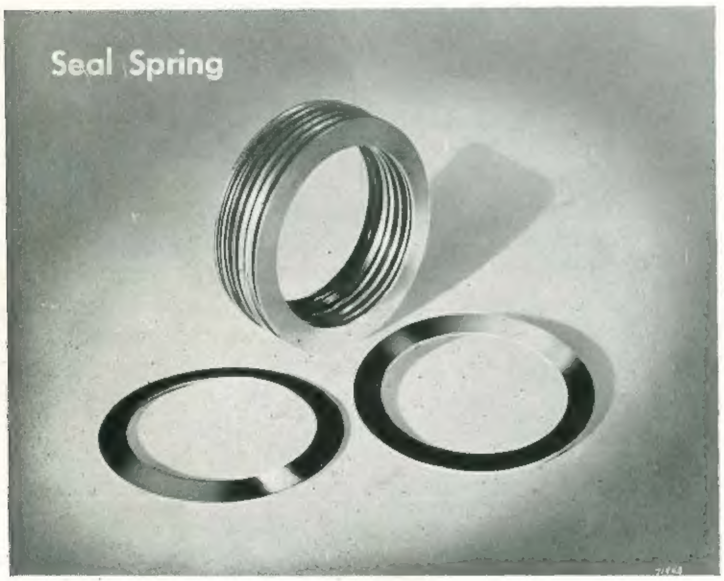
The shaft sleeve, on which the seal's rotating parts are mounted, is very much like a standard sleeve with this exception—instead of a smooth cylindrical surface against which the packing would bear, it has a shoulder and a keyway to mount and hold the seal parts.



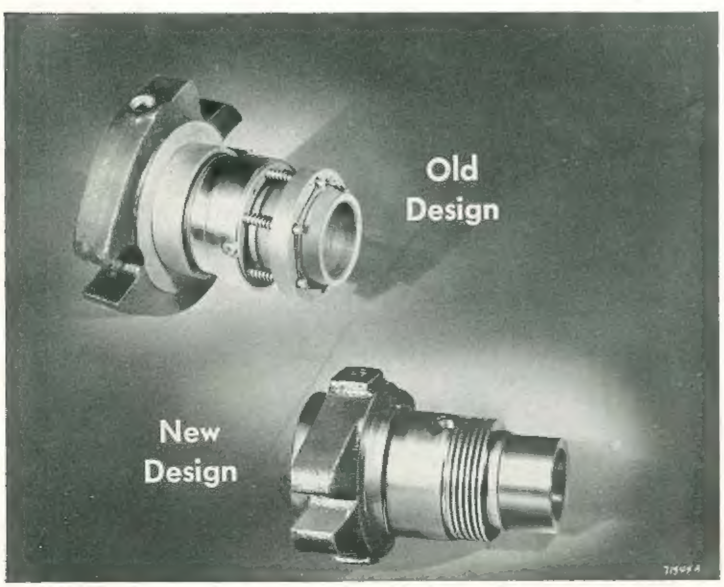
The seal spring bears against the shoulder on the shaft sleeve . . . and against the locking collar.



Its job is to provide enough initial pressure to hold the rotating seal face against the stationary seal face . . . to prevent any leakage through the joint while the pump is not in operation. Its construction is somewhat unusual—it might be well to have a closer look and see how it works.



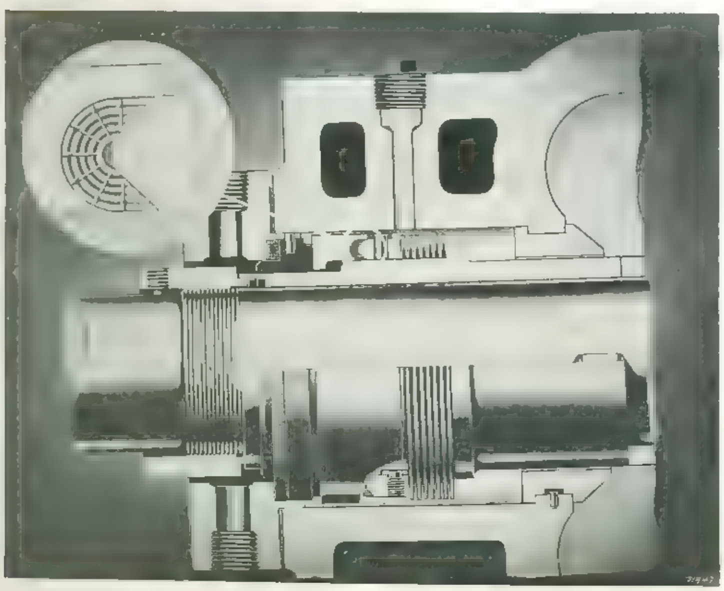
Each of its rings is dished in the middle and resembles a saucer with the center cut out. When a number of these rings are assembled with their dished edges facing one another, they make a spring having a very smooth action.



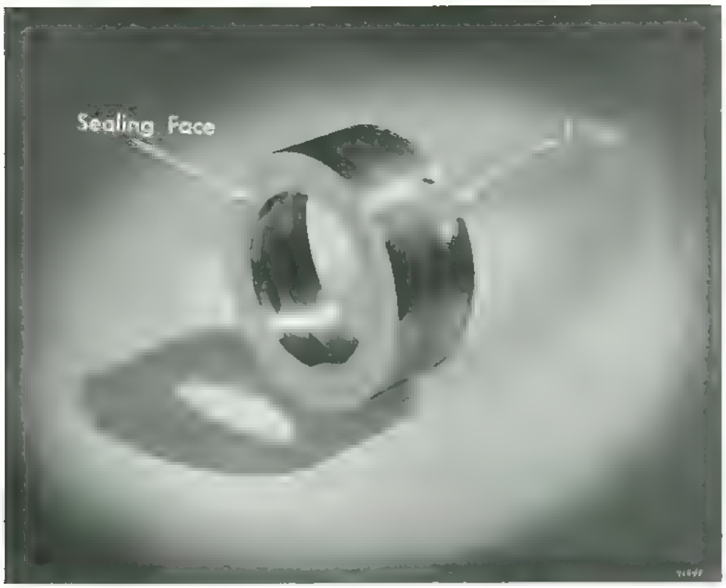
The seal spring's disc-like construction is much stronger than the coil springs and pins used in older designs . . . and is easier to assemble or disassemble. It is less apt to break, having heavier sections . . . and it provides absolutely uniform loading because its annular design corresponds to the ring shape of the locking collar against which it acts.

Now the next piece we come to is the locking collar which is keyed to the shaft sleeve . . . but free to move, axially, the length of the key-way along the sleeve.

The rotating seal ring packing acts as a flexible mounting for the seal ring and since all parts rotate together, there is no wear on the packing.

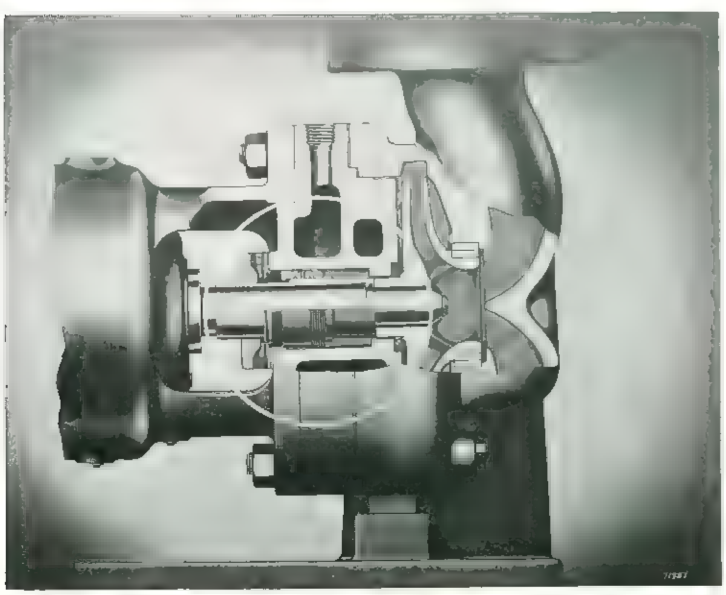


A sectional view reveals that the locking collar, when pressing against the packing ring, exerts equal pressure in all directions . . . providing a leakproof seal between the shaft sleeve and the seal ring.

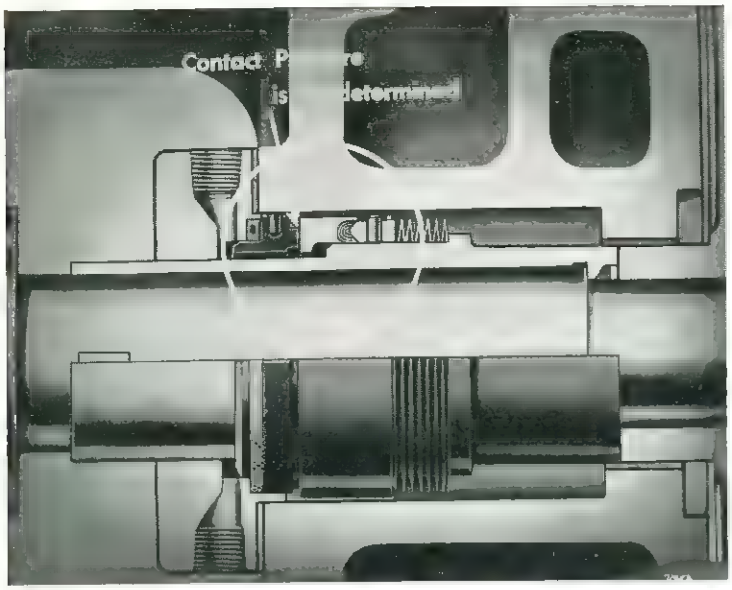


Finally, there is the rotating seal ring which is positively-held to the locking collar by a pin which fits into a T-slot in its circumference. The face of the rotating seal ring, as it spins against the stationary face, provides the sealing action.

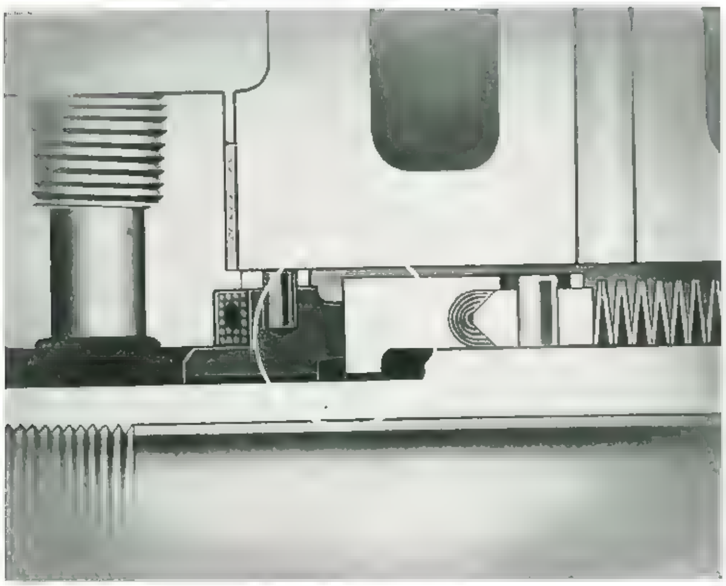
These two faces, with perhaps two square inches of sealing surface, make up the heart of the Shaft-Seal and successfully prevent leakage from the pump where complicated stuffing boxes, with six or seven packing rings, have failed to do the job. Briefly, the seal works like this . . .



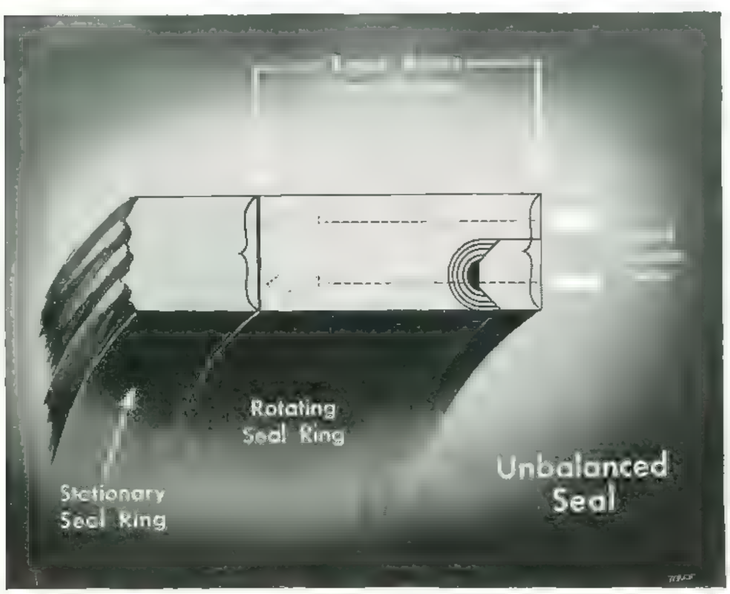
The circle shows the location of the Shaft-Seal as installed on a single-stage process pump. The liquid will try to work its way out of the pump . . .



. . . at the point indicated by the arrow, since all other joints are absolutely tight. But balanced pressures, carefully predetermined by the designer provide the correct contact-pressure for the successful sealing action which holds the liquid within the pump . . .

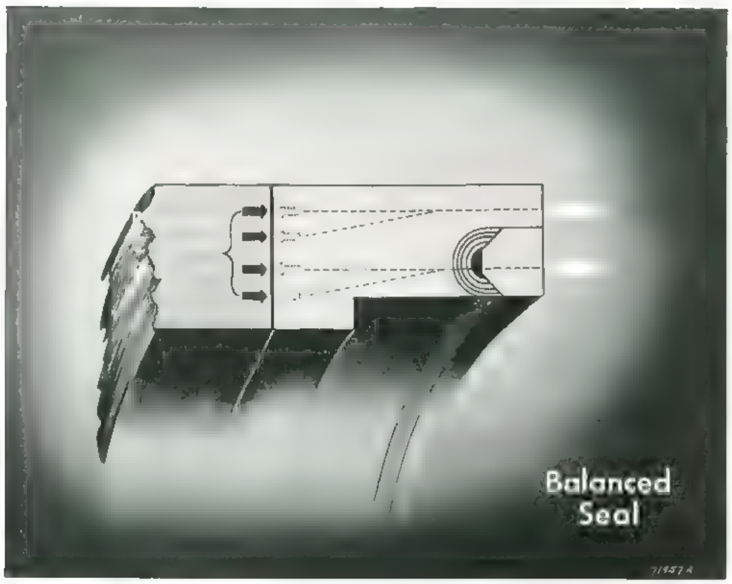


. . . allowing only a small leakage, of a few drops a minute, to provide the necessary film of lubrication between the seal faces.

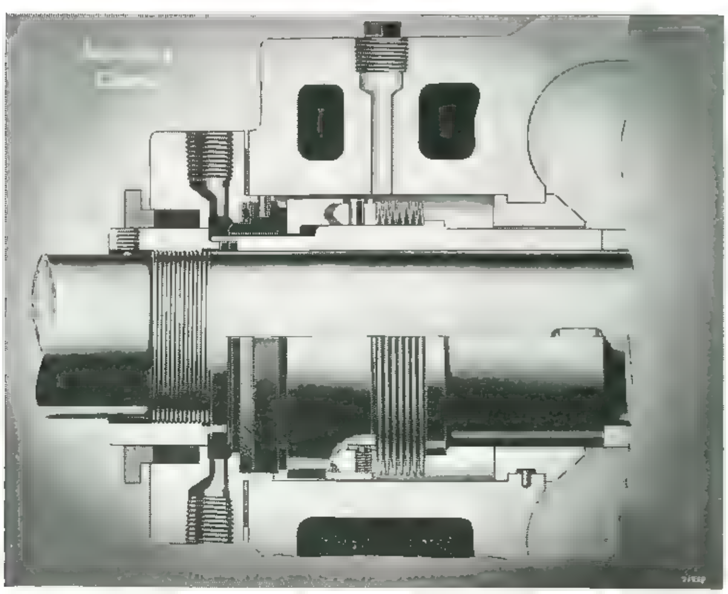


The pressure of the liquid, in an unbalanced seal, pushes the rotating ring against the face of the stationary ring. If all this pressure was applied against the seal face, having the same area as the loading surface, the contact pressure would be too great and the seal faces would wear or burn out.

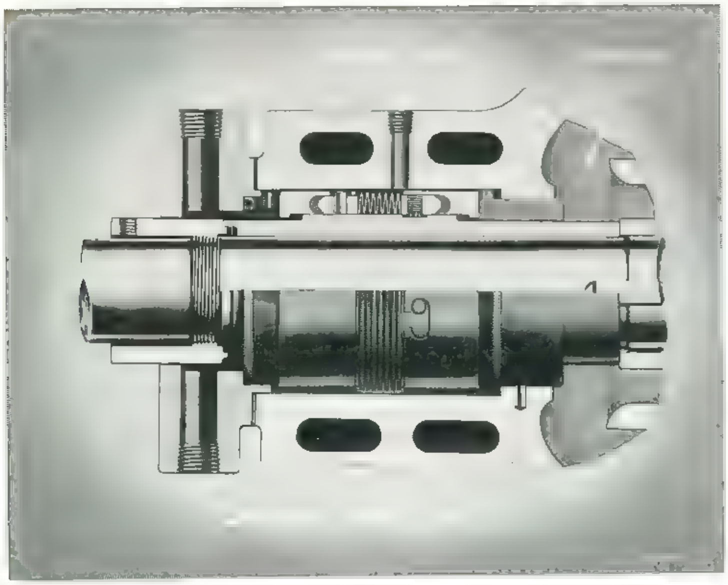
In order to reduce the contact pressure, under the same loading conditions, our engineers increased the area of the seal faces. This distributes the load over a larger surface . . . and reduces the unit pressure on the seal faces . . .



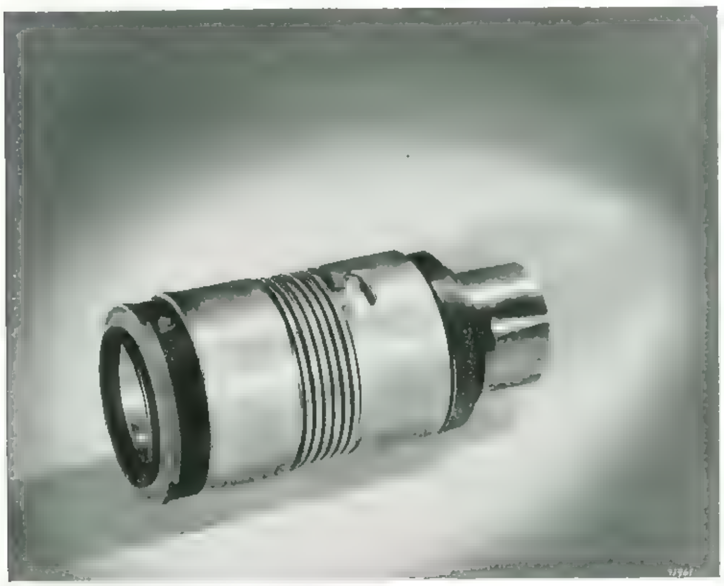
. . . thus obtaining absolute control of the resultant contact pressure . . . producing a perfectly balanced seal. This eliminates the necessity for lubricating devices and makes it the most effective seal on the market.



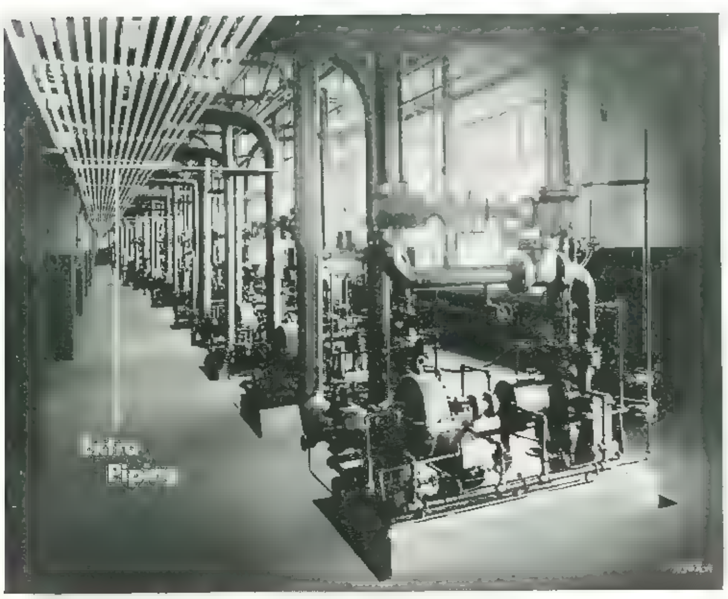
One variation of the Cameron Shaft-Seal makes use of an auxiliary packing gland for handling volatile liquids that vaporize at atmospheric pressure. This gland confines the vapor so it can be vented to a torch-line. Another variation used when pumping excessively corrosive liquids, and liquids at temperatures from 350°F. to 500°F . . .



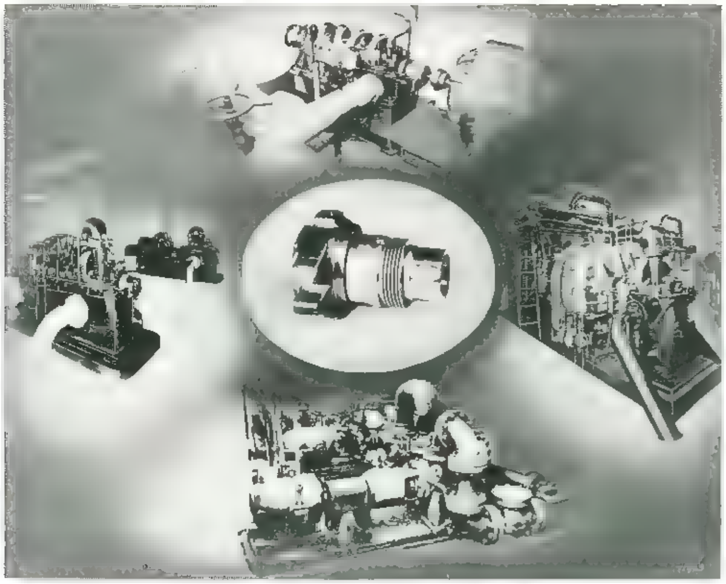
. . . is the Double Shaft-Seal. Notice the sealing fluid introduced between the two seals under pressure higher than pump pressure. This keeps the pump liquid away from the seal faces. Leakage on the atmosphere side is normal . . . on the pump side it is reduced because it acts against the pump pressure.



However, the double seal is necessary in very few cases. The blanced design of the single Cameron Shaft-Seal, and the non-corroding metals used in it, make it suitable for ninety-nine percent of the applications which arise. In the case of the Double Shaft-Seal . . .

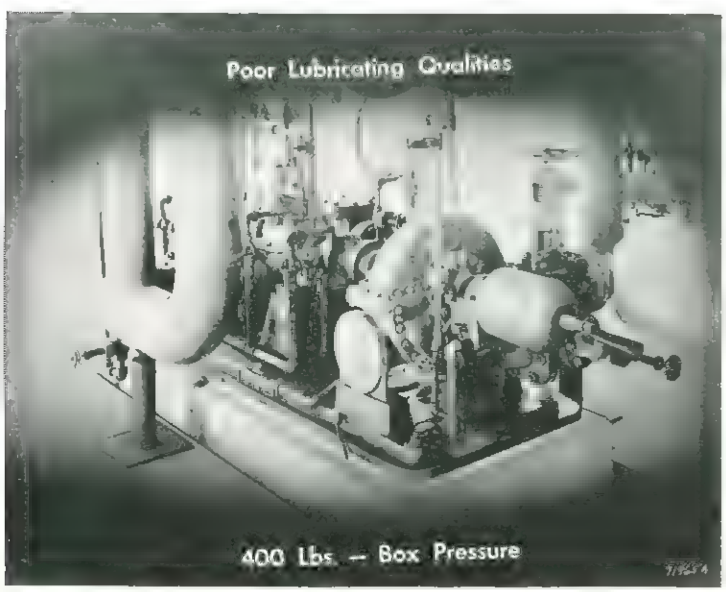


. . . its use involves extra piping for the injection liquid . . . and auxiliary pumps to maintain the required pressure on the liquid. Notice that the first pump requires no extra overhead piping—it is equipped with a single Cameron Shaft-Seal and is handling the same liquids as the other pumps which all have double seals.

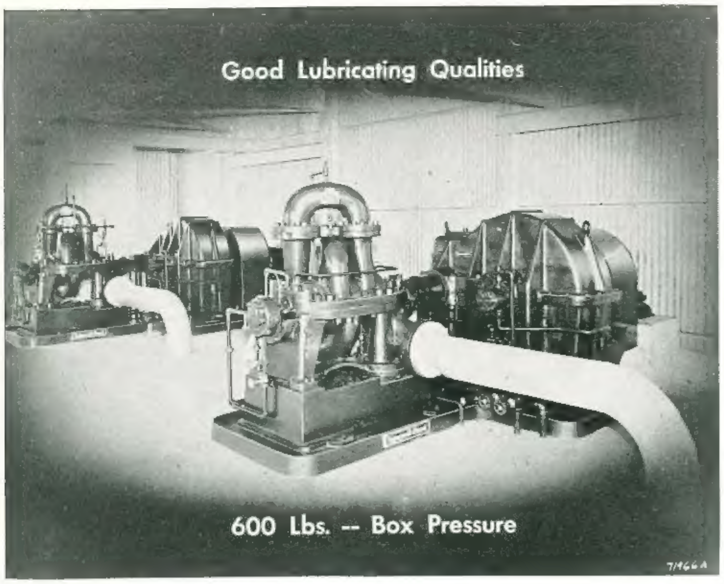


Cameron Shaft-Seals have been in successful operation for over seventeen years . . . installed on new Cameron pumps as well as Ingersoll-Rand pumps already in service . . . handling fluids of many types.

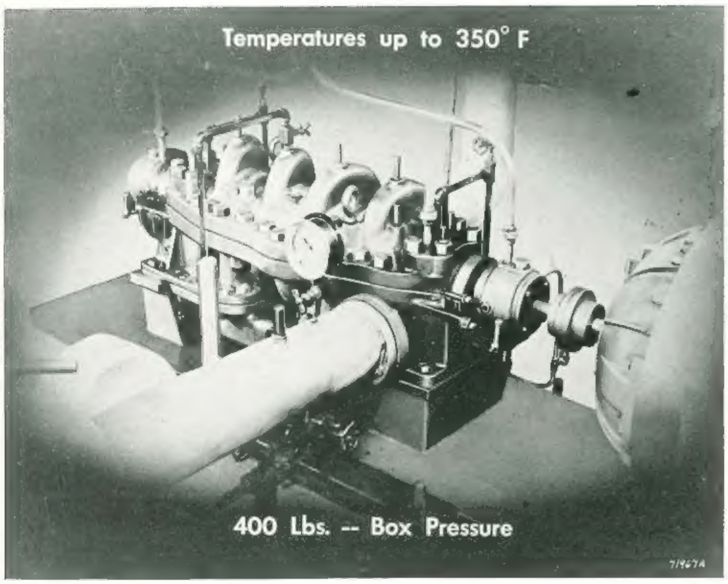
The long list of liquids embraces crude oil and its derivatives, such as butane, propane and gasoline . . . various acids . . . solutions such as calcium sulphite . . . and many others. Shaft-Seals have proved their worth in many industries, under a wide variety of conditions. For instance, their range of application has included . . .



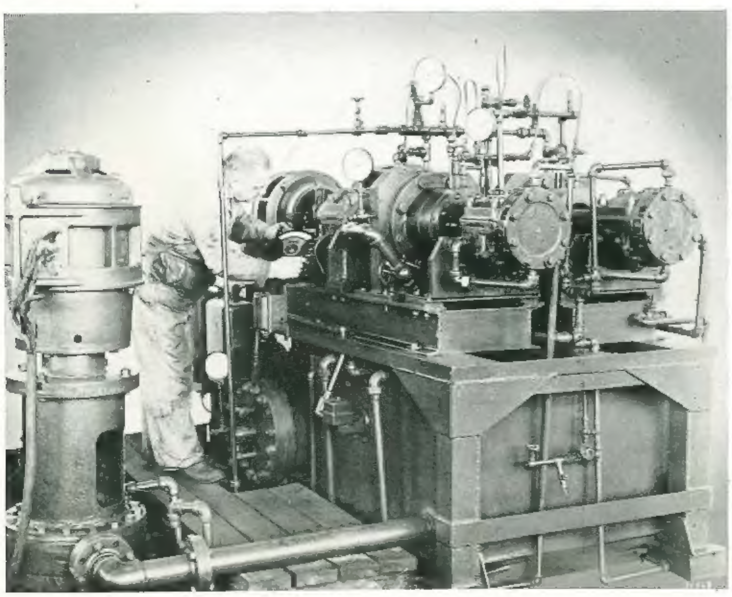
. . . stuffing box pressures of 400 pounds for liquids with poor lubricating properties . . .



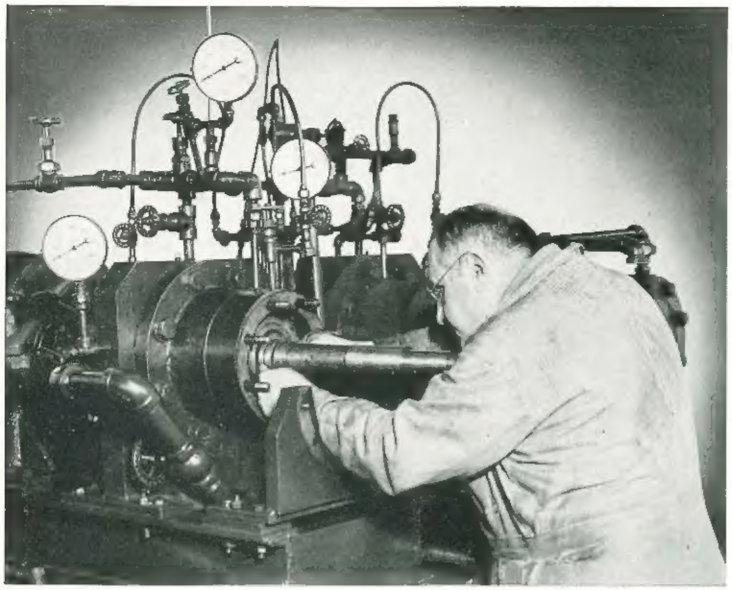
. . . or 600 pounds pressure when handling cold liquids with good lubricating properties . . .



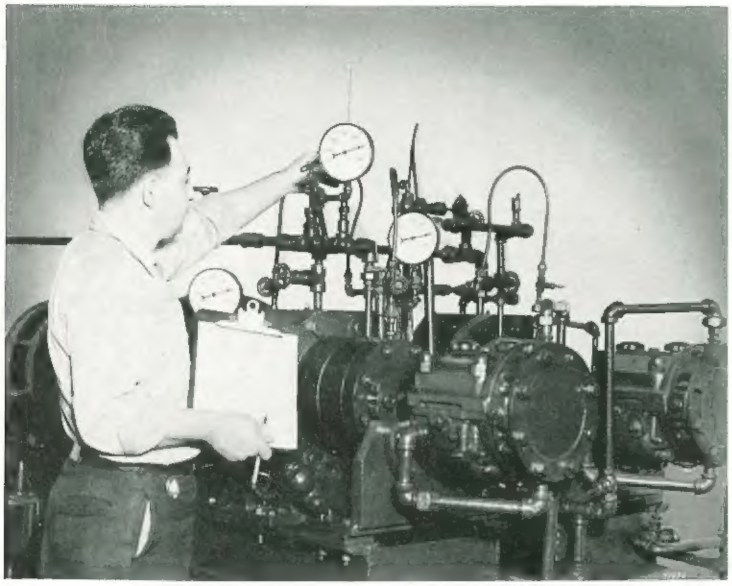
. . . and liquids with temperatures as high as 350 degrees on stuffing boxes with 400 pounds pressure. In fact, trials are being run continuously . . .



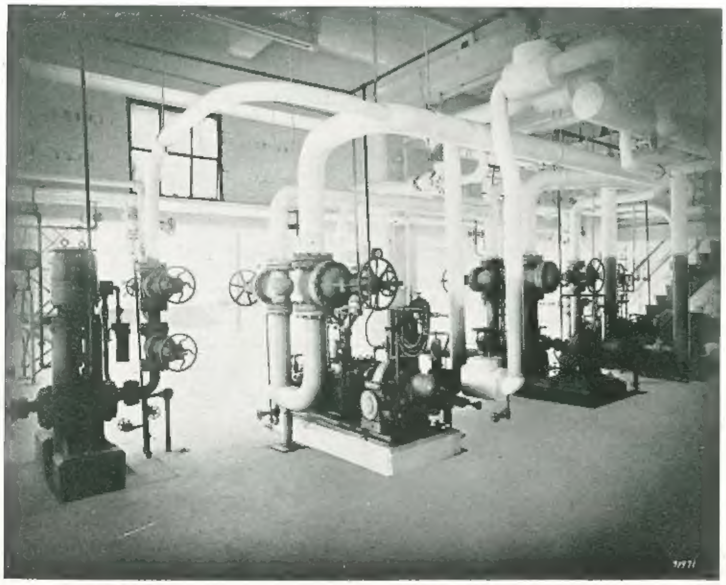
. . . on specially-built testing machines which impose conditions on the Shaft-Seal far more severe than any yet encountered in actual service.



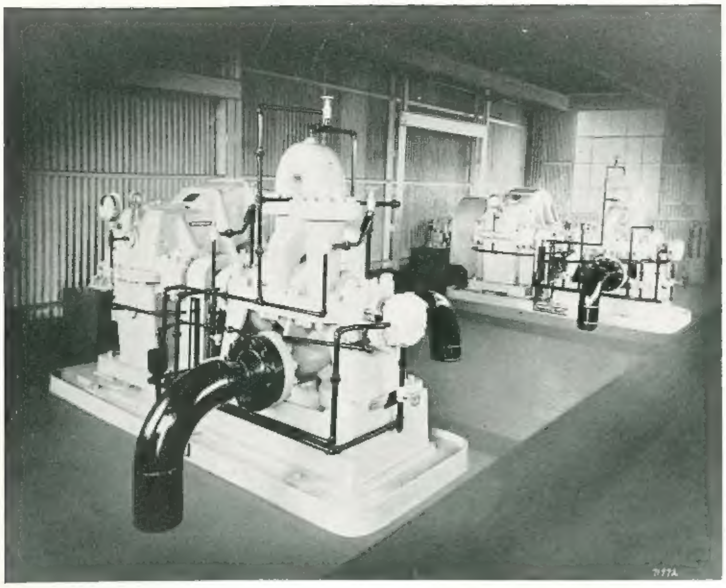
The specific gravity of the liquid handled is varied from four tenths to one and six tenths. The viscosity ranges from that of propane, all the way to that of the very heaviest crude oils.



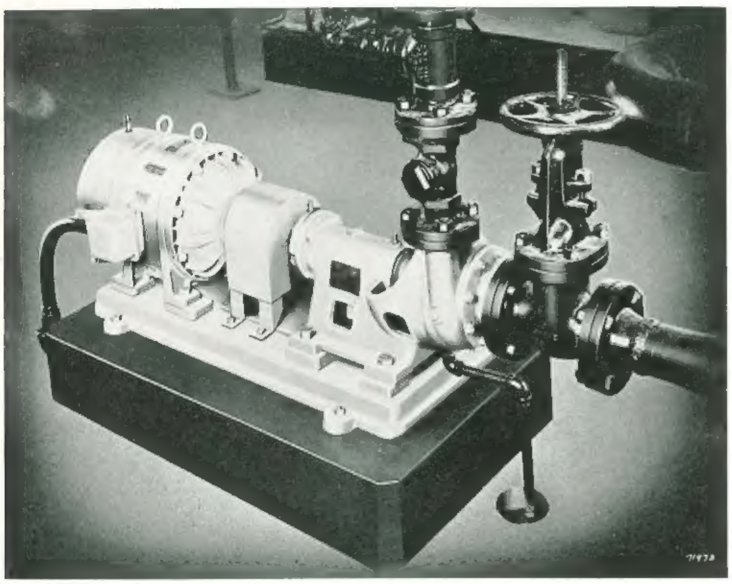
And, as our engineers carry on with their new and more rigorous tests, the field of application is constantly being extended . . .



. . . on refinery pumps, handling a multitude of hot and cold liquids . . .

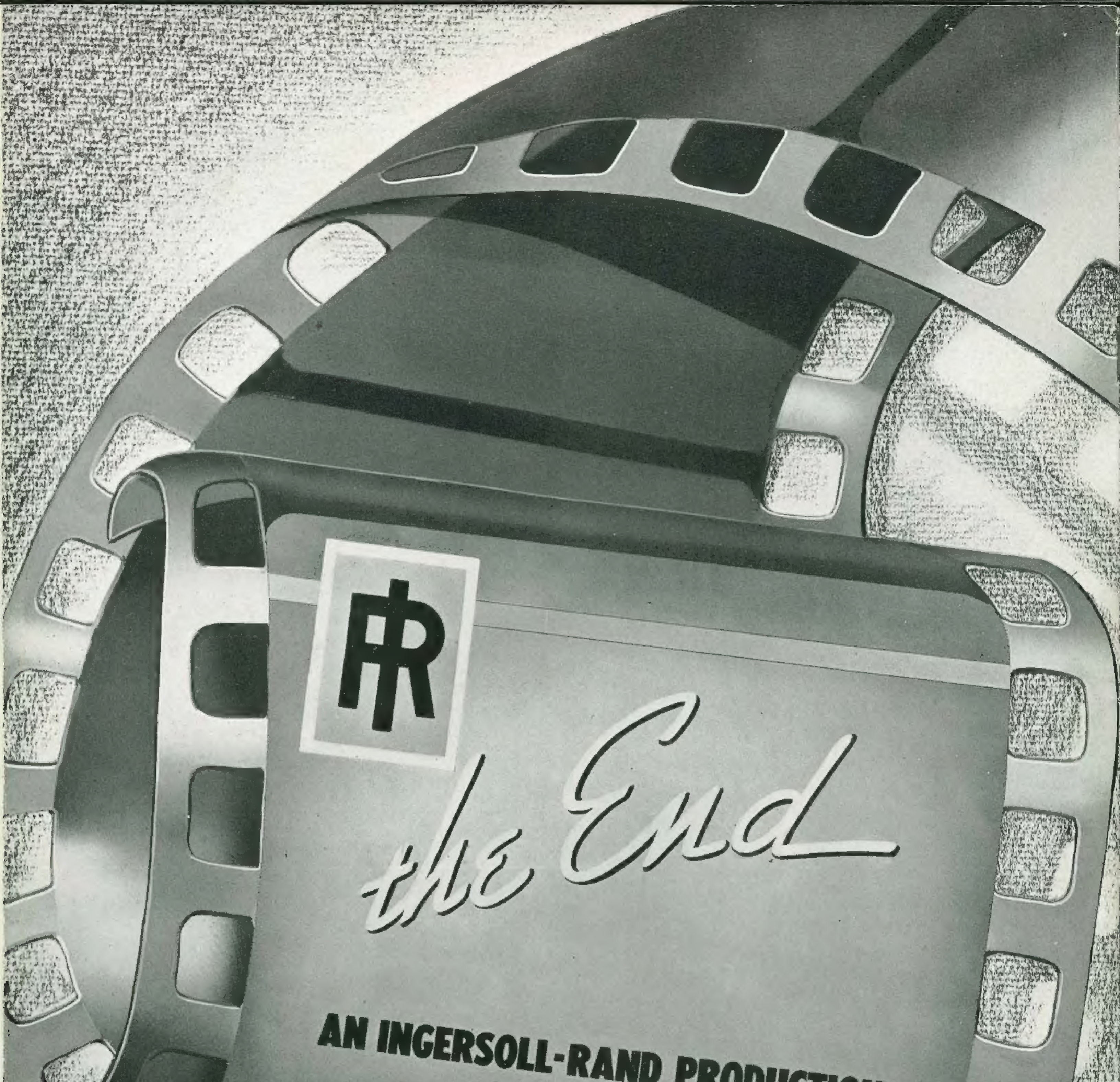


. . . on pipeline pumps, transporting crude oil and finished products over great distances . . .



. . . on pumps for chemical processing service . . . and in many other industries where pumps have a need for the most efficient seal ever developed . . .

. . . the Cameron Shaft-Seal.



Ingersoll-Rand

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